## Space Weather Technical Forecast

Issued on Wednesday 25 September 2024 at 01:11 Local

**This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**On the 24th of September, the way we distribute this forecast has changed and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk**

**Space Weather Forecast Headline: G1/Minor Geomagnetic Storm likely, mainly Day 1 (25 Sep) due to coronal hole high speed stream and a possible glancing blow CME. Chance of M-flares (R1-R2 Blackouts).**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Activity has been Low with a flare peaking at C6.9 at 24/1146 UTC from AR3828 in the southwest quadrant.

There are currently nine sunspot regions on the visible disc. AR3836 in the far southeast of the disc, is currently the largest region, although remains difficult to assess due to its viewing angle. However, it appears to show some complexity, with a possible 'delta' spot developing within the penumbra of its large spot, although this should become clearer as it continues to rotate away from the east limb. There appears to be some notable looping in SDO imagery associated with AR3836, so this region remains one to watch. AR3828 in the southwest is the next largest region, but is a uni-polar spot and appears to be stable. AR3835 in the southeast, continues to show some growth within its intermediate portion. The remaining regions on the disc appear to be mostly simple and stable.

A CME observed on 22-23 Sep, appears to be directed primarily to the south and east, mostly away from Earth. However, analysis suggests a possible glancing blow on Day 1 (25 Sep), likely from the shock associated with the CME. No other Earth-directed CMEs were observed.

**Solar Wind / Geomagnetic Activity:** The solar wind, as measured by ACE and DSCOVR at L1, started the period at slightly elevated levels, near 490km/s, with a declining trend down to background levels, near 380km/s. Wind speeds have recently increased back to Slightly Elevated levels, currently near 440km/s. Density was above average initially, peaking at 33 ppcc at 24/0045 UTC, gradually declining to average, before increasing to above average by the end of the period. Interplanetary Magnetic Field, Bt, was moderate to weak, increasingly to moderate late in the UTC day, currently peaking at 10-11nT. The north-south component, Bz, was moderately southward

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directed at the start of the period, then weakly northward until 24/0630 UTC, becoming mostly weak to moderately southward directed, down to -8nT. Phi angle was negative (towards the Sun) orientated at the start of the period, then mostly positive (away from the Sun) from 24/0130 UTC. Geomagnetic activity was mostly Quiet to Unsettled (Kp 1-3).

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux observed by GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels. The associated 24-hour fluence was below the Active threshold, with a continuing declining trend. The 25/0000 UTC observation was 2.25e6 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Low to Moderate activity is expected, with a chance of isolated M-class flares.

**Solar Wind / Geomagnetic Activity:** The partial halo CME following the M3.7 flare off the southeast quadrant on 22 Sep may give a glancing blow at Earth on Day 1 (25 Sep) with effects potentially lasting into Day 2 (26 Sep). This may coincide with the arrival of any CIR or connection to the fast wind from CH72/+. However, this aspect of the forecast is considered to be low confidence. Solar wind speeds are currently slightly elevated under the influence of what appears to be a weak transient CME, which arrived midday UTC on 23 Sep, and are likely to remain so with the arrival of any connection to the fast wind from CH72/+. If we also experience a glancing blow from the above mentioned CME then solar winds could potentially become elevated.

Geomagnetic activity is forecast to be Quiet to Unsettled at first. If we see a combination of coronal hole fast wind and the glancing CME on Days 1-2 then this could bring the likelihood of Active to G1/Minor Storm intervals. However, if we see more than just shock influence from the CME, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching G2-G3/Moderate-Strong Storm intervals. This is currently considered to be low confidence. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled during Days 3 and 4 (27-28 Sep).

**Energetic Particles / Solar Radiation:** High energy proton flux at GOES18 is likely to remain at background levels. High energy electron flux at GOES16 is now at background levels and is expected to remain so. Fluence should remain below the Active (1e8 integrated pfu) threshold.

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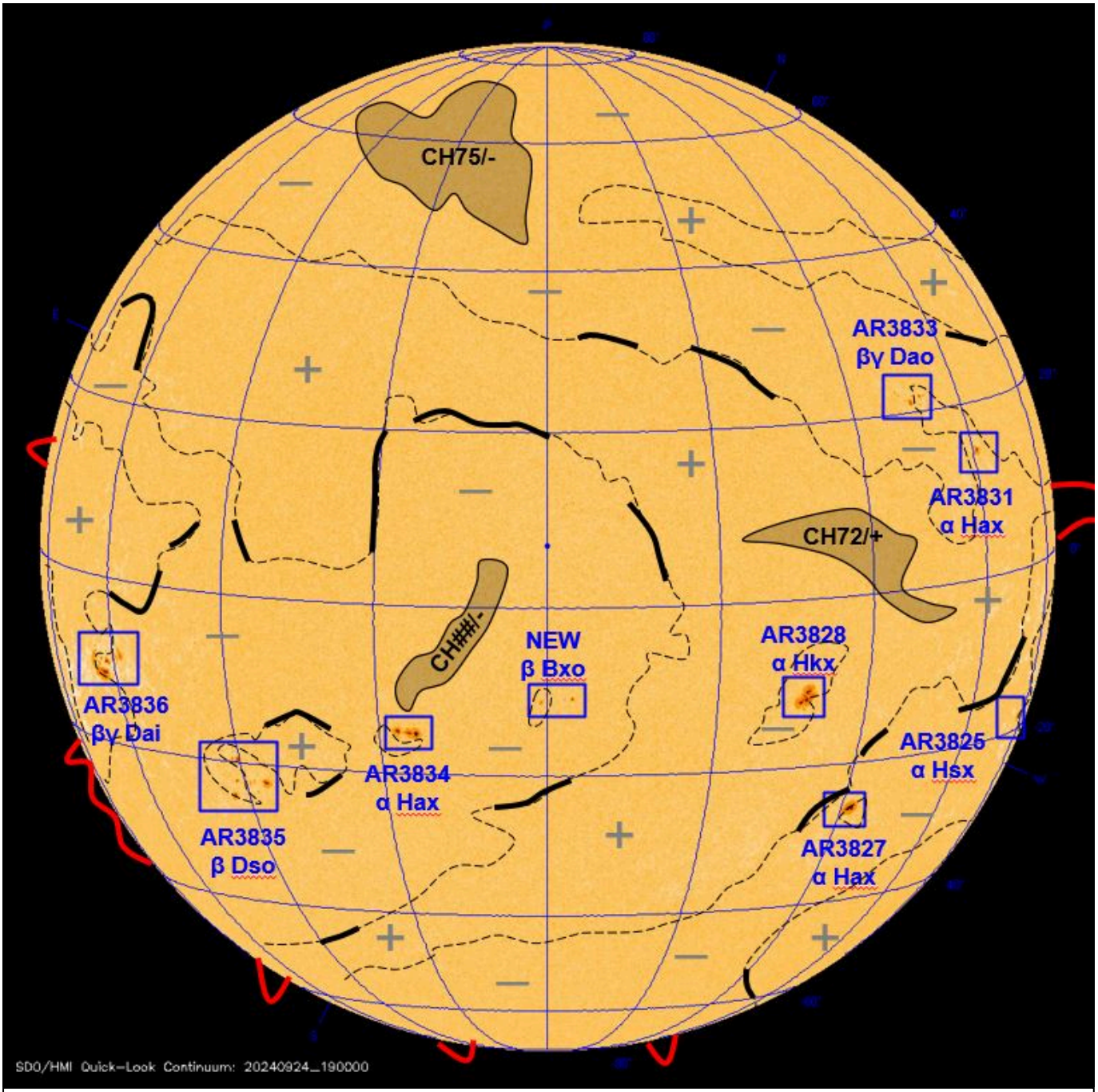
**Figure 1: Solar Analysis Valid 24/1900 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms

The partial halo CME which was observed following the M3.7 flare off the southeast quadrant on 22 Sep has been analysed. Results suggest a possible glancing blow on Day 1 (25 Sep) with effects potentially lasting into Day 2 (26 Sep). The bulk of the material appears to be heading below and behind Earth's orbit. However, coronagraph imagery suggests that some shock effects could reach Earth. This may coincide with the arrival of any CIR or connection to the fast wind from CH72/+. However, this aspect of the forecast is considered to be low confidence.

Solar winds are currently slightly elevated and are likely to remain so with a connection to the fast wind from CH72/+. If we also experience a glancing blow from the above mentioned CME then levels could potentially become elevated. The coronal hole is a persistent feature and is in a generally similar location when compared to previous rotation, but is more defined and extends slightly further west on this occasion. However, on the previous rotation any impacts were largely swamped by ongoing CME effects. With the positive polarity of the coronal hole and the proximity of the September Equinox, this would suggest the possibility of some geomagnetic enhancement associated with this feature, although wind speeds did not go much above 400 km/s on the previous rotation and similar wind speeds are likely this time. This largely fits with MOSWOC Enlil's forecast.

Geomagnetic activity is forecast to be Quiet to Unsettled at first. If we see a combination of CH72/+ fast winds and CME influence on Days 1-2 (25-26 Sep) then this will bring a likelihood of Active to G1/Minor Storm intervals. However, if we see more than just shock influence from the CME, then geomagnetic activity could become more significantly enhanced, with a slight chance of reaching G2-G3/Moderate-Strong Storm intervals. This is currently considered to be low confidence. Geomagnetic activity is likely to gradually ease to Quiet to Unsettled during Days 3 and 4 (27-28 Sep).

| Geomagnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Minor or Moderate** | **G1 to G2** | No | 60 | 30 | 10 | 5 |
| **Strong** | **G3** | No | 20 | 10 | 1 | 1 |
| **Severe** | **G4** | No | 1 | 1 | 1 | 1 |
| **Extreme** | **G5** | No | 1 | 1 | 1 | 1 |

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**Geomagnetic Activity - Earthbound Coronal Mass Ejections**

| Date/time 21.5R⊙ (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed (km/s) | Estimated Arrival Time (UTC) | Comments |
|---|---|---|---|---|---|---|
| 2024-09-23 00:31Z | Partial | Filament | SE | 1195 km/s | 2024-09-25 12:00Z | M3.7 from filament eruption between AR3834 and AR3835. Middle ground of two separate fits |

**Figure 2: MOSWOC Enlil, showing a likely CME glancing blow on Day 1 (25 Sep).**

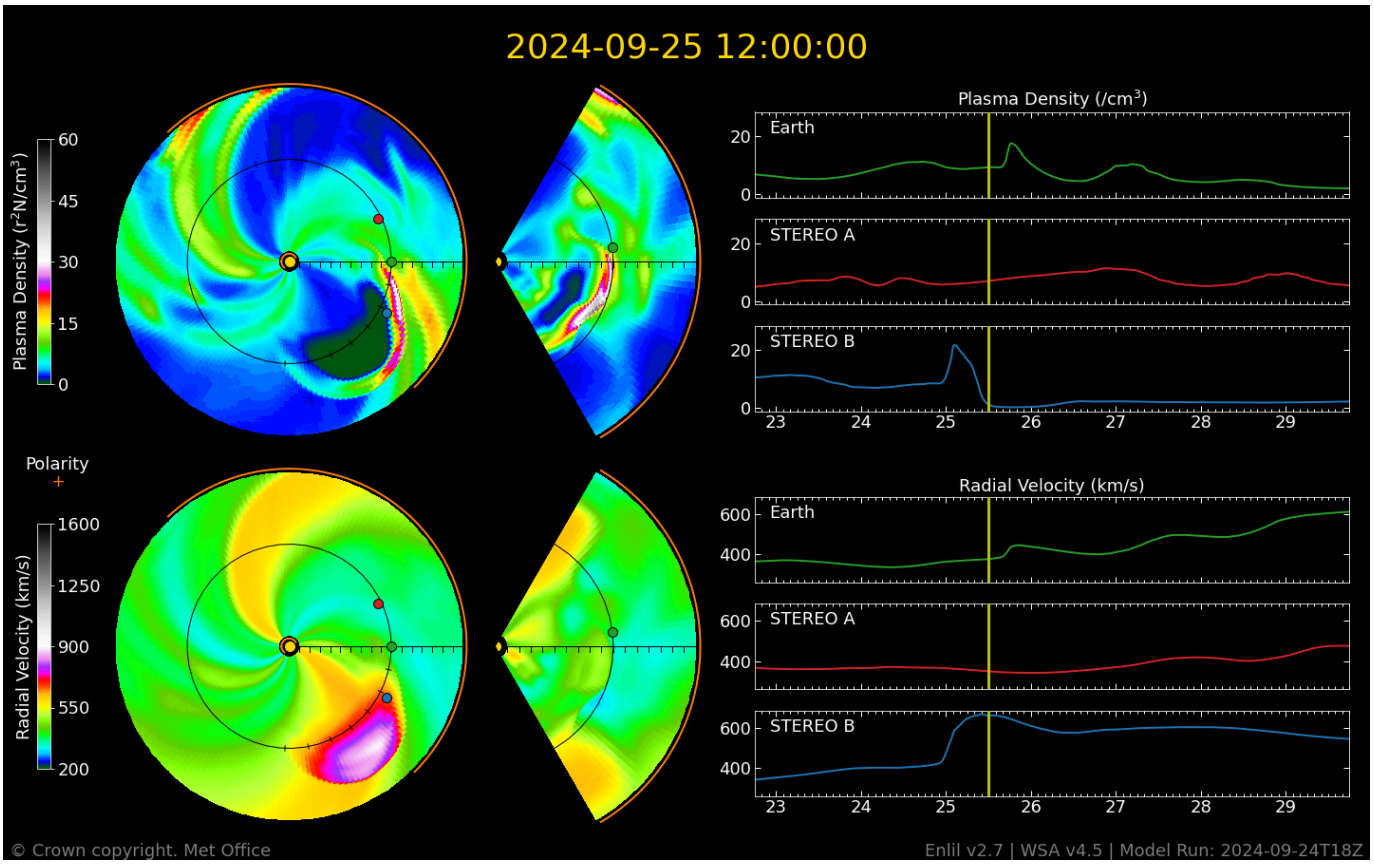


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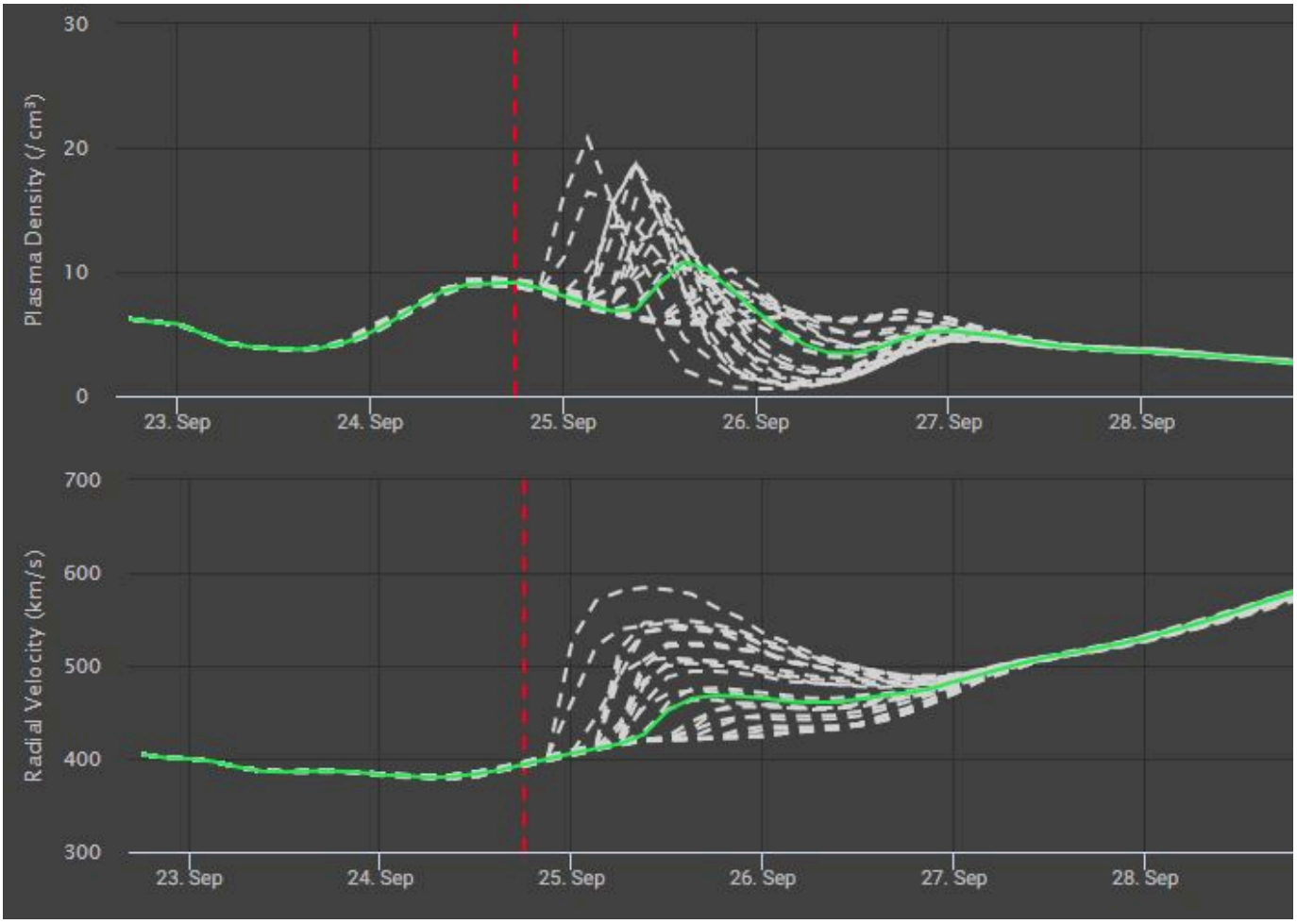
**Figure 3: MOSWOC Enlil ensemble - shows a spread in members for the arrival time of the glancing CME on 25 Sep.**



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## Radio Blackouts - X-Ray Flares

Activity is Low with a peak C6.9 flare at 24/1146 UTC from AR3838 in the southwest. Activity is expected to remain Low to Moderate, with a Chance of isolated M-class flares, most likely from AR3828, AR3833, or AR3836.

There are currently nine sunspot regions on the visible disc. AR3836 (Dai/Beta-Gamma) in the far southeast of the disc, is currently the largest region, although remains difficult to assess due to its viewing angle. However, it appears to show some complexity, with a possible 'delta' spot developing within the penumbra of its large spot, although this should become clearer as it continues to rotate away from the east limb. There appears to be some notable looping in SDO imagery associated with AR3836, so remains one to watch. AR3828 (Hkx/Alpha) in the southwest is the next largest region, but is a uni-polar spot and appears to be stable. AR3835 (Dso/Beta) in the southeast, continues to show growth in its intermediate portion. The remaining regions appear mostly small or simple.

Far-sided imagery does suggest further regions are due to rotate onto the disc in the coming days, especially towards the southeast quadrant. This is also evident in the SDO/AIA 171 imagery, with a lot of magnetic looping seen on, or just beyond the east limb.

| X-Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 (M Class) | No | 40 | 40 | 40 | 40 |
| Very Active | R3-R5 (X Class) | No | 5 | 5 | 5 | 5 |

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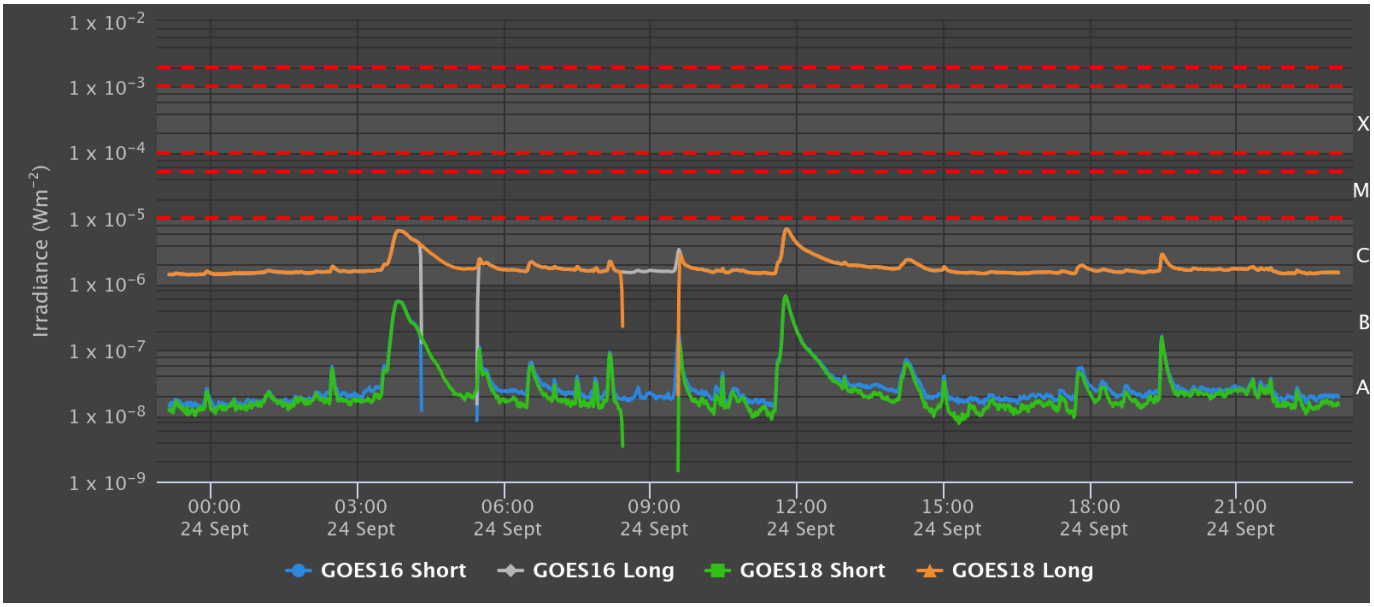
**Figure 4: GOES X-Ray Flux trace.**



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## Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is forecast to persist at background levels, with only a very slight chance of rising above the S1/Minor Radiation Storm threshold.

The majority of the sunspots on the disc are either small or simple. However, the slight complexity apparent in AR3833 in the northwest results in a very slight chance of proton productive flares. There is also a non-zero, albeit very low chance of observable protons from any significant filament eruption, given the number and size of notable filaments currently on the disc.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}sr^{-1}s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 5 | 5 | 5 | 5 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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## High Energy Electrons (≥ 2MeV)

GOES-16 high energy electron flux is now at background to moderate levels. Due to potential HSS and CME effects, the subsequent increased solar wind pressure could compress the radiation belts once again. There is potential for another increase in flux later in the period, after CME and HSS effects have subsided.

The associated 24 hour fluence reached the Active (1e8 integrated pfu) level during 22-23 Sep but has since dropped below the threshold, likely due to the recent weak CME arrival, which arrived midday UTC on 23 Sep. Confidence is low during this period, but it seems most likely that fluence will remain below the Active threshold, before potentially rising on Day 4 (28 Sep). MOSWOC REFM also suggests a gradual rising trend towards the end of the period, but remains below the threshold.

| GEO Electron Environment | Level ($cm^{-2}sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1\times10^{8}$ | No | 1 | 1 | 5 | 10 |
| Very Active | ≥ 2 MeV ≥ $1\times10^{9}$ | No | 1 | 1 | 1 | 1 |

**Figure 5: GOES16 Electron Flux.**

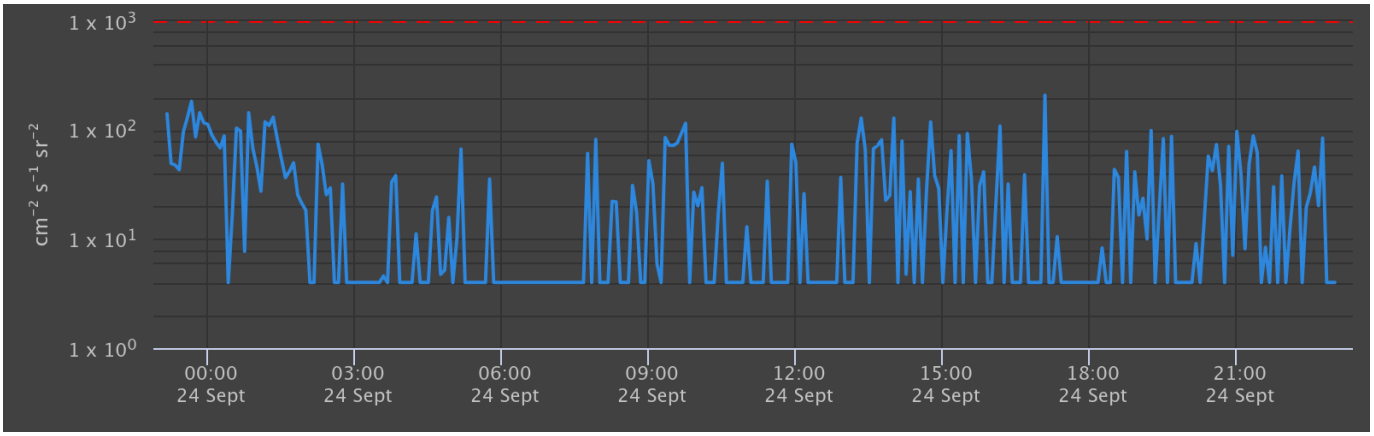


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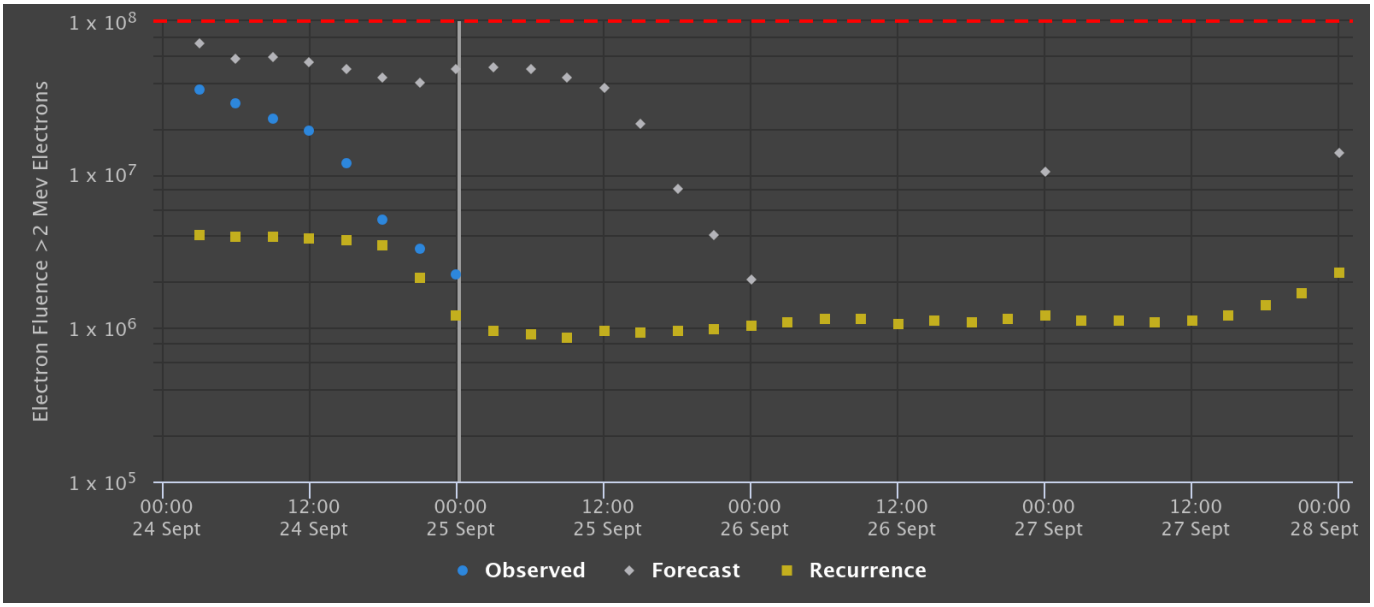
**Figure 6: REFM Electron Fluence.**



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